MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2015/2016

ETM2046 – ANALOG AND DIGITAL COMMUNICATIONS

(BE, RE)

08 OCTOBER 2015
2.30 p.m - 4.30 p.m
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This question paper consists of 8 pages including cover page with 4 questions only.

2. Attempt ALL 4 questions. All questions carry equal marks and the distribution of the marks for each question is given.

3. Please write all your answers in the answer booklet provided.

QUESTION 1

a) Sketch the block diagram of Digital Communication System. [10 marks]

b) Find the Trigonomertric Form Fourier series representation for the sawtooth waveform as shown in Fig Q1 below. [10 marks]

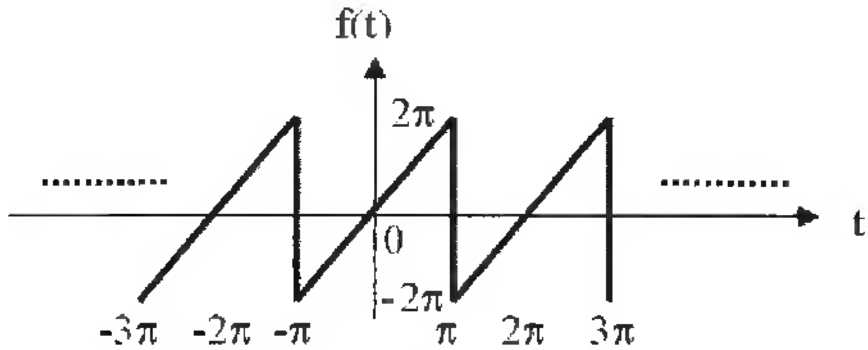

Fig. Q1

c) An SSB transmission contains 700W. This transmission is to be replaced by a standard AM signal with the same power content. Determine the power content of the carrier and each of the sidebands when the percent modulation is 80%.

[3 + 2 marks]

Continued ....

QUESTION 2

a) Explain direct FM signal generation. [6 marks]

b) List out the TWO advantages and TWO disadvantages of direct FM signal generation. [2 + 2 marks]

c) An FM signal is given as $x(t) = 10\cos(2\pi \times 10^6 t + 0.05\cos(\pi \times 2000t))$. Determine:

(i) the instantaneous frequency $f_i(t)$. [2 marks]

(ii) whether $x(t)$ is narrowband or wideband FM. Also state the reason for your answer. [2 marks]

(iii) the transmission bandwidth using Carson's rule. [2 marks]

(iv) the transmission bandwidth using Bessel function table. [2 marks]

(v) the power in the largest sidebands. [2 marks]

d) Sketch the block diagram of a Phase Lock loop FM Detector. [5 marks]

Continued ....

QUESTION 3

a) Explain in details the "Quantisation Process" in Pulse Modulation. [7 marks]

b) The voltage range being input to a PCM system is 0 to 2 V. A 4-bit A/D converter is used to convert the analog signal to digital values.

(i) How many quantization levels are provided? [2 marks]

(ii) What is the resolution (quantisation step) of each level? [2 marks]

(iii) What is the range of the quantization error for this system? [2 marks]

(iv) What is the SNR in dB? [2 marks]

c) List out the two modes of adaptive equalization and briefly explain each of them. [2 + 2 marks]

d) Draw the encoded bits for [1 0 1 1 0 1 0 1 1 0] using:

(i) Unipolar RZ [2 marks]

(ii) Unipolar NRZ [2 marks]

(iii) Manchester [2 marks]

Continued ....

QUESTION 4

a) State Shannon's First Theorem. [2 marks]

b) Consider a discrete memoryless source with source alphabet $\{S_0,S_1,S_2\}$ with probabilities $p_0=1/4$, $p_1=1/4$ and $p_2=1/2$. The codeword assigned for each source alphabet $\{S_0,S_1,S_2\}=\{00,01,1\}$.

(i) Calculate the average code word length. [2 marks]

(ii) Calculate the efficiency of the source encoder. [4 marks]

c) List out the SEVEN steps of Huffman Coding. [7 marks]

d) For the following symbols and their related probabilities,

Symbol	Probability
S_0	0.4
S_1	0.25
S_2	0.25
S_3	0.05
S_4	0.05

(i) Determine the codeword. [4 marks]

(ii) Determine the average codeword length. [2 marks]

(iii) Determine the entropy. [2 marks]

(iv) Determine the efficiency for the symbols. [2 marks]

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Appendix I: Table of Bessel Function

n \ β	0.05	0.1	0.2	0.3	0.5	0.7	1.0	2.0	3.0	5.0	7.0	8.0	10.0
0	0.999	0.998	0.990	0.978	0.938	0.881	0.765	0.224	-0.260	-0178	0.300	0.172	-0.246
1	0.025	0.050	0.100	0.148	0.242	0.329	0.440	0.577	0.339	-0.328	-0.005	0.235	0.043
2		0.001	0.005	0.011	0.031	0.059	0.115	0.353	0.486	0.047	-0.301	-0.113	0.255
3				0.001	0.003	0.007	0.020	0.129	0.309	0.365	-0.168	-0.291	0.058
4						0.001	0.002	0.034	0.132	0.391	0.158	-0.105	-0.220
5								0.007	0.043	0.261	0.348	0.186	-0.234
6								0.001	0.011	0.131	0.339	0.338	-0.014
7									0.003	0.053	0.234	0.321	0.217
8										0.018	0.128	0.223	0.318
9										0.006	0.059	0.126	0.292
10										0.001	0.024	0.061	0.208
11											0.008	0.026	0.123
12											0.003	0.010	0.063
13											0.001	0.003	0.029
14												0.001	0.012
15													0.005
16													0.002
17													0.001

Appendix II: Table of Trigonometric Identities

$$\sin A \sin B = \frac{1}{2}\left[\cos(A-B) - \cos(A+B)\right]$$

$$\cos A \cos B = \frac{1}{2}\left[\cos(A+B) + \cos(A-B)\right]$$

$$\sin(A+B) = \sin A \cos B + \cos A \sin B$$

$$\cos(A+B) = \cos A \cos B - \sin A \sin B$$

$$\sin\theta = \frac{1}{2j}\left[e^{j\theta} - e^{-j\theta}\right]$$

$$\cos\theta = \frac{1}{2}\left[e^{j\theta} + e^{-j\theta}\right]$$

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Appendix III: Fourier Transform Pairs

$x(t)$	$X(f)$
$\delta(t)$	1
$\delta(t-t_o)$	$e^{-j2\pi f t_o}$
1	$\delta(f)$
$e^{j2\pi f_o t}$	$\delta(f-f_o)$
$e^{-at}u(t)$	$\dfrac{1}{a+j2\pi f}$, for $a>0$
$e^{at}u(-t)$	$\dfrac{1}{a-j2\pi f}$, for $a>0$
$e^{-a\|t\|}$	$\dfrac{2a}{a^2+(2\pi f)^2}$, for $a>0$
$rect\left(\dfrac{t}{T}\right)$	$T\mathrm{sinc}(fT)$
$\mathrm{sinc}(2Wt)$	$\dfrac{1}{2W} rect\left(\dfrac{f}{2W}\right)$
$\Delta\left(\dfrac{t}{T}\right)$	$\dfrac{T}{2}\mathrm{sinc}^2\left(\dfrac{fT}{2}\right)$
$W\mathrm{sinc}^2(Wt)$	$\Delta\left(\dfrac{f}{2W}\right)$
$e^{-\pi t^2}$	$e^{-\pi f^2}$
$\cos(2\pi f_o t)$	$\dfrac{1}{2}\delta(f-f_o)+\dfrac{1}{2}\delta(f+f_o)$
$\sin(2\pi f_o t)$	$\dfrac{1}{2j}[\delta(f-f_o)-\delta(f+f_o)]$

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Appendix IV: Fourier Transform Properties

Let $x(t) \Leftrightarrow X(f)$, $x_1(t) \Leftrightarrow X_1(f)$ and $x_2(t) \Leftrightarrow X_2(f)$; and a, b, t_o and f_o scalar quantities.	
Linearity	$ax_1(t)+bx_2(t) \Leftrightarrow aX_1(f)+bX_2(f)$
Scaling ($a \neq 0$)	$x(at) \Leftrightarrow \frac{1}{\|a\|} X\left(\frac{f}{a}\right)$
Time Shifting	$x(t-t_o) \Leftrightarrow X(f)e^{-j2\pi f t_o}$
Frequency Shifting	$x(t)e^{j2\pi f_o t} \Leftrightarrow X(f-f_o)$
Time Convolution	$x_1(t) * x_2(t) \Leftrightarrow X_1(f)X_2(f)$
Frequency Convolution	$x_1(t)x_2(t) \Leftrightarrow X_1(f) * X_2(f)$
Time Differentiation	$\frac{d^n}{dt^n} x(t) \Leftrightarrow (j2\pi f)^n X(f)$
Frequency Differentiation	$(-jt)^n x(t) \Leftrightarrow \frac{d^n}{df^n} X(f)$
Time Integration	$\int_{-\infty}^{t} x(\tilde{t})d\tilde{t} \Leftrightarrow \frac{X(f)}{j2\pi f} + \frac{1}{2} X(0)\delta(f)$
Frequency Integration	$x(t)u(t) \Leftrightarrow \int_{-\infty}^{f} X(\tilde{f})d\tilde{f}$

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